# INVESTIGATOR'S ANNUAL REPORT

United States Department of the Interior

National Park Service

All or some of the information you provide may become available to the public.

OMB # (1024-0236)
Exp. Date (11/30/2010)
Form No. (10-226)

| **Reporting Year:** 2010 | **Park:** Shenandoah NP | **Select the type of permit this report addresses:** Scientific Study |
|---|---|---|

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|---|---|
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|---|---|---|
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**Project Title (maximum 300 characters):**

Assessing the role of rock type and geologic structure in controlling rates of Appalachian landscape evolution

| **Park-assigned Study or Activity #:** | **Park-assigned Permit #:** | **Permit Start Date:** | **Permit Expiration Date:** |
|---|---|---|---|
| SHEN-00353 | SHEN-2008-SCI-0014 | Jul 14, 2008 | May 31, 2011 |

| **Scientific Study Starting Date:** | **Estimated Scientific Study Ending Date:** |
|---|---|
| Jul 14, 2008 | May 31, 2011 |

**For either a Scientific Study or a Science Education Activity, the status is:**

Continuing

**For a Scientific Study that is completed, please check each of the following that applies:**

__ A final report has been provided to the park or will be provided to the park within the next two years

__ Copies of field notes, data files, photos, or other study records, as agreed, have been provided to the park

__ All collected and retained specimens have been cataloged into the NPS catalog system and NPS has processed loan agreements as needed

**Activity Type:**

Research

**Subject/Discipline:**

Geology / General

**Purpose of Scientific Study or Science Education Activity during the reporting year (maximum 4000 characters):**

The beauty and unique habitats of Shenandoah National Park arise in large part from the high, rugged and varied topography of the Blue Ridge Mountains. How such rugged topography continues to exist despite the cessation of mountain building processes in this region hundreds of millions of years ago is an outstanding geologic puzzle. In this light, the Appalachians provide an accessible location to investigate topographic evolution in mountain chains that survive long after the initial, tectonically driven uplift has ceased.

To understand how this topography is evolving currently, and to determine what controls the rate and style of topographic evolution, we seek to answer two very basic questions: 1) is the topography of Shenandoah National Park decaying, growing, or remaining stable over timescales of millions of years? and 2) how do rock lithology, landscape morphology, and climate control rates of landscape change at the local to regional scale?

The direction of topographic change has been investigated in other regions of the central and southern Appalachians, with interesting and conflicting results. Recent work in Great Smoky Mountains National Park has suggested that the topography there is in â steady stateâ , meaning all elements of the landscape are eroding at the same rate and that topography changes little through time (Matmon et al. 2003). In contrast, work on the Appalachian Plateau just west of Shenandoah National Park strongly suggests that the topography (i.e., relief and ruggedness) is instead increasing through time, as rivers are eroding at rates substantially faster than high summits are being lowering (Hancock and Kirwan 2007). Both results contrast with prior suggestions of decaying relief (e.g., Braun 1989) through time, which might intuitively be expected in a mountain range of great age.

Addressing the questions posed above requires measuring rates of landscape elevation change (e.g., erosion rates) from various locations within the range. We propose a systematic study, in support of the USGS National Cooperative Geologic Mapping Program Appalachian Blue Ridge Project (study SHEN-00306, permit SHEN-2007-SCI-0017), to determine landscape erosion rates using the abundance of the cosmogenic radionuclide 10Be in exposed rocks and sediments at key locations within Shenandoah National Park. The isotope 10Be is produced in situ in material exposed near the Earthâ s surface through natural bombardment by cosmic rays, and the abundance of this isotope in geologic material is an indication of the length of time of exposure at or near the surface. This technique is widely used in geomorphic studies to obtain such information (e.g., Gosse and Phillips 2001), and the primary permit applicant (Hancock) has extensive experience in using this technique (e.g., Hancock et al. 1999; Farber et al. 2005; Hancock and Kirwan 2007). We note that the US Geological Survey has already granted funding for this project for the period 2007-2010.

These data will form the basis of a regional database of surface lowering rates that will be expanded in the future. Future projects will include fluvial incision rates obtained from major streams adjacent to the Blue Ridge, basin-averaged erosion rates from watersheds of varying lithology, along the Blue Ridge Parkway across the schists and metagraywackes that underlie Blue Ridge escarpment, and south into the southern Appalachian Highlands of Grandfather Mountain, Mount Mitchell (the highest ground in the eastern U.S.), and the Great Smoky Mountains National Park region of TN/NC. Eventually, transects across the Blue Ridge from the Piedmont west to the Alleghany Plateaus Province will be incorporated.

**Findings and status of Scientific Study or accomplishments of Science Education Activity during the reporting year (maximum 4000 characters):**

We have collected 35 samples from key locations for determining erosion rates. The primary emphasis has been measurement of 10Be in rocks exposed at or near summits to determine the rate of erosion of the highest portions of the Park landscape. These samples have been collected from bedrock outcrops of Harpers, Pedlar, Antietam, and Catoctin Formations and the Old Rag Granite. We have measured the abundance of 0Be in 20 samples thus far, and these have yielded bare-bedrock erosion rates of 2.51 - 41.19 m/My. Bedrock type appears to strongly influence erosion rates, with the Antietam and Pedlar Formations yielded remarkably slow erosion rates (4.8 and 5.5 m/My average, respectively) relative to the Harpers Formation (23.4 m/My average).

Thus far, the project has produced one senior research thesis (Whitten, 2009) and a publication in the Virginia Geological Field Conference field trip guide from October 2009 (Hancock and Whitten, 2009).

I intend to continue to collect additional summit erosion rate samples through the end of the permit period, this time focusing on the use of detrital quartz weathering from rocks rather than bare-bedrock samples. These additional samples will also be analyzed for 10Be to determine erosion rates averaged over larger areas than the single point rate provided by bedrock surfaces.

**For Scientific Studies (not Science Education Activities), were any specimens collected and removed from the park but not destroyed during analysis?**

No

| **Funding specifically used in this park this reporting year that was provided by NPS (enter dollar amount):** | **Funding specifically used in this park this reporting year that was provided by all other sources (enter dollar amount):** |
|---|---|
| $0 | $25000 |

**List any other U.S. Government Agencies supporting this study or activity and the funding each provided this reporting year:**

**Paperwork Reduction Act Statement:** A federal agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. Public reporting for this collection of information is estimated to average 1.625 hours per response, including the time for reviewing instructions, gathering and maintaining data, and completing and reviewing the forms. Direct comments regarding this burden estimate or any aspect of this form to Dr. John G. Dennis, Natural Resources (3127 MIB), National Park Service, 1849 C Street, N.W., Washington, DC 20240.